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Training Command
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AOM 6403

STUDENT OUTLINE

MAINTAIN HMMWVA2 ENGINE COOLING SYSTEM

LEARNING OBJECTIVES:

1. Terminal Learning Objective: Given a HMMWVA2 vehicle, TM 9-2320-280-20-1&2, tools, test equipment, and shop supplies, perform organizational maintenance on the HMMWVA2 engine cooling system, per the references. (6.4.2)

2. Enabling Learning Objectives: Given a HMMWVA2 vehicle, TM 9-2320-280-20-1&2, tools, test equipment, and shop supplies, per the references:

    a. Inspect coolant hoses and fittings. (6.4.2a)

    b. Check surge tank coolant level. (6.4.2b)

    c. Test coolant for freeze protection. (6.4.2c)

    d. Pressure test the cooling system. (6.4.2d)

    e. Inspect the fan blades. (6.4.2e)

    f. Test fan drive. (6.4.2f)

    g. Replace serpentine drive belt. (6.4.2g)

    h. Test fan time delay module. (6.4.2h)

    i. Test fan drive solenoid. (6.4.2i)

    j. Test fan temperature control switch. (6.4.2j)

OUTLINE

1. INTRODUCTION TO THE HMMWVA2 ENGINE COOLING SYSTEM

a. Purpose of the Engine Cooling System. The cooling system removes excess heat from the engine, engine oil, transmission and transfer oil.

b. Principles of Operation. The HMMWVA2 employs a liquid cooling system. A pump forces the coolant through jackets and passages within the engine block and cylinder heads. As coolant circulates, heat is transferred from the engine to the coolant. After flowing through jackets and passages, coolant passes through the radiator where heat is transferred to air that is created by the fan and forward movement of the vehicle.

c. Water Pump

(1) As you can see on the drawing, the water pump is mounted on the front of the engine block.

(2) The water pump is belt driven from the engine crankshaft pulley and draws coolant through a hose connected to the bottom of the radiator.

(3) From the radiator, the pump forces coolant through jackets and passages within the engine block and head.

d. Fan Blade and Fan Drive

(1) As stated earlier, the fan pulls air through the radiator to speed removal of excess heat from the engine coolant.

(2) The fan drive is a clutch assembly, activated by a time delay module and temperature control switch. During normal operation the time delay module is closed. This keeps the hydraulic control valve in the open position allowing hydraulic fluid supplied by the power steering pump to disengage the fan drive. As the engine temperature reaches approximately 230 degrees, the temperature control switch opens, this information is relayed to the fan solenoid, closing the control valve. The absence of hydraulic fluid allows the fan drive to engage.

(3) A clutch is a device used to couple or uncouple components. A clutch is used because engine horsepower is required to drive the fan and it is desirable to save the power when there is no requirement for fan operation.

e. Radiator and Fan Shroud

(1) The radiator is made of numerous rows of vertical tubes that connect the upper and lower radiator tanks. Sandwiched between rows of tubes are thin metal fins. As coolant passes through tubes to the lower tank, the fins conduct

the heat away from it and dissipate this heat to the atmosphere. Dissipation of the heat from the fins is aided by the fan and forward movement of the vehicle directing an airflow between the tubes and over the fins.

(2) The fan shroud permits a greater volume of air to be pulled through the radiator and channels the incoming air more efficiently to the tubes and fins.

f. Oil Cooler Assemblies. Transmission, transfer, and power steering oil coolers are located on top of the radiator, the transmission and transfer oil cooler is divided into two parts. The bottom half cools the engine oil and the top half cools the transmission and transfer oil; although the power steering cooler is a separate cooling element, both oil coolers operate in the same manner as the radiator. Outside air is drawn through the cooler and around a series of tubes and baffles so that excess heat is removed from the oil.

g. Hydraulic Control Valve

(1) A hydraulic control valve, fan drive solenoid, and time delay module are located in the left rear corner of the engine compartment, next to the windshield washer reservoir.

(2) The hydraulic control valve is designed to direct hydraulic fluid under pressure to disengage the fan drive.

h. Time Delay Module. When the accelerator is at full throttle, the fan cut-off switch relays a message to close the time delay module. This action opens the hydraulic control value allowing hydraulic fluid, supplied by the power steering pump to temporarily disengage the fan drive for approximately 20 seconds, providing horse power for acceleration that would otherwise be used by the fan drive.

i. Fan Temperature Control Switch. When the engine reaches a temperature of about 230 degrees, the temperature control switch opens and sends a message to the fan solenoid to close the hydraulic control valve. The absence of hydraulic fluid allows the fan drive to engage.

j. Engine Temperature Sending Unit. An engine temperature sending unit is mounted in the left side of the engine block and sends engine coolant temperature information to the temperature gage mounted on the instrument panel.

k. Water Crossover. Located on the top front of the engine block is the water crossover. It collects coolant from the cylinder heads and channels it through the thermostat, a by-pass hose connecting the crossover directly into the water pump. Cooling systems equipped with a by-pass arrangement have coolant circulation within the engine water jackets when the thermostat is closed.

l. Thermostat. The thermostat is located in the housing created by the junction of the radiator inlet hose and water crossover.

m. Surge Tank. The surge tank is a coolant reservoir and is connected to the radiator by a hose. As coolant heats during engine operation, coolant overflow caused by the expansion of coolant is directed to the surge tank. As the system cools, the coolant in the tank will be drawn back into the radiator. The surge tank is also used to check and fill coolant to the correct level. The surge tank is fitted with a standard pressure cap that you are familiar with.

2. INSPECT AND TEST HMMWVA2 ENGINE COOLING SYSTEM COMPONENTS

a. Hoses and Fittings.

(1) Visually inspect hoses for cracks, distortion, brittleness, sponginess, damage and security of mounting.

(2) Inspect for coolant residue or rust stains that will indicate the presence of a leak.

(3) Pressure testing the cooling system will cause weakened radiator hoses to swell excessively, thus being detected.

b. Pressure Cap

(1) Check the gasket on the cap to make sure it is not deformed, swollen, torn or otherwise unserviceable.

(2) Also check the sealing surface of the cap and surge tank for nicks or other damage that would prevent proper sealing.

(3) The vacuum valve can be inspected visually by observing that the valve and spring operate correctly.

(4) When testing the cap with a pressurized tester, the cap should hold pressure up to 15 pounds per square inch and relieve pressure over 15 pounds per square inch.

c. Drive Belt and Pulleys.

(1) Check drive belt for cracks, fraying, gouges, glazing, and excessive wear.

(2) Inspect pulleys for cracks, breaks, burrs, and nicks.

d. Radiator.

(1) Inspect the radiator core for breaks, punctures, leaks, and corrosion.

(2) Inspect soldered seams for cracks, splits, leaks, and corrosion.

(3) Inspect all fittings and radiator mounts for security.

(4) Small leaks in the radiator not evident during a visual inspection may be detected by pressure testing the cooling system. Do not apply more pressure to the system than it is designed for; 15 pounds per square inch.

e. Fan Blades and Fan Drive

(1) Inspect fan blades for cracks, chips, distortion, or other damage. The fan blade assembly is balanced and any damage may cause the premature failure of adjacent components or disintegration of the fan blade assembly during operation.

(2) Check the fan blade assembly for excessive wobble or looseness.

(3) With the engine off, inspect the fan drive by attempting to turn the fan by hand. If the fan can be turned, it must be replaced. The procedure for replacing the fan drive will be covered later in the lesson.

f. Inspect Engine Temperature Gage and Wiring

(1) Inspect electrical wiring and connectors for cracked or broken insulation, bare or broken wires, and loose or broken connectors.

(2) Check operation of the temperature gage. The normal temperature range of the engine during operation is 190 to 230^{o}F.

g. Inspect the Temperature Sending Unit and wire connections

(1) Look for leaks around edges of the temperature sending unit.

(2) Check wiring and connector for correct fit, completeness, and corrosion.

h. Test Thermostat If you suspect that the thermostat is not working, wait until the engine is cold and remove the thermostat. Place it in a container of hot water known to be about 190°F. The thermostat valve should open. Replace the thermostat if the valve fails to work.

i. Test Fan Operation. If the fan does not operate, test the fan time delay module.

j. Test Fan Time Delay Module. When the engine is at operating temperature, unplug the time delay module from the control valve. If the fan does not operate continuously, replace the time delay module.

k. Test Fan Temperature Switch. Check the fan temperature switch for continuity.

(1) Disconnect engine harness leads 458A and 458B at the fan temperature switch located on the left side of the water crossover.

(2) Using a multimeter, check the fan temperature control switch for continuity between leads.

(3) With the engine coolant temperature above 215°, the switch should be open; no continuity. With the engine temperature below 215°, the switch should be closed; continuity. If the switch does not test correctly, replace it.

l. Test Fan Drive

(1) With the engine off, try to turn the fan by hand. If you can, the fan drive is unserviceable and must be replaced.

(2) Test fan drive solenoid resistance.

(a) Using a multimeter, check for resistance between the connector terminals.

(b) The resistance should be approximately 65 ohms. If it is not, replace the hydraulic control valve.

m. Test Radiator Coolant. Test coolant for freeze protection with an antifreeze and battery tester.

n. Test Engine Temperature Monitoring Circuit

(1) Troubleshooting the engine temperature monitoring circuit consists of testing and eliminating each component: the sending unit, the wiring harness, and dash-mounted temperature gage.

(2) To test the temperature gage, disconnect lead 33B from the coolant temperature sending unit. Turn the master/start switch to the "RUN" position. The coolant temperature gage should read minimum temperature. Touch lead 33B to ground, the coolant temperature gage should read maximum temperature. If the coolant temperature gage operates properly, replace the coolant temperature sending unit.

(3) To test the temperature sending unit, disconnect leads 33A, 27G, and 58E from the coolant temperature gage. Using a multimeter, check for battery voltage at lead 27G with master/start switch in the "RUN" position; then check for continuity from lead 58E to ground; and for continuity from lead 33A at the coolant temperature gage to lead 33B at the temperature sending unit. If all leads test correctly, but the temperature gage does not register properly, replace the temperature sending unit. If any leads do not test correctly, repair the body wiring harness.

3. SERVICE HMMWVA2 ENGINE COOLING SYSTEM

a. Depressurize Cooling System

(1) Do not remove the surge tank filler cap before depressurizing the system when engine temperature is above 190F. Steam or hot coolant under pressure will cause severe burns.

(2) If the engine is hot, remove the surge tank filler cap by placing a thick cloth over the cap, press down and turn the cap counterclockwise to its first stop to release internal pressure.

(3) After pressure has escaped, press down and turn the cap counterclockwise again and remove it.

b. Drain Cooling System

(1) If the engine is hot, depressurize the system, as has just been explained. Have a drainage container available to catch coolant from the radiator drain cock tube that is located on the bottom right side of the radiator return tube.

(2) Open the drain cock and allow the system to drain.

(3) Flush the system, if required.

(4) Close the drain cock.

c. Fill Cooling System

(1) Make sure the radiator drain cock is completely closed.

(2) Fill the system with proper antifreeze solution. See Table 3-1 of TM 9-2320-280-20-2 for preparation of antifreeze solutions. The cooling system for vehicles covered in this lesson have a 26 quart capacity. Continue filling and allow air to escape. Make sure the surge tank coolant level is 3/4 full before securing the filler cap.

(3) Secure the filler cap to the surge tank.

(4) Operate run the engine at fast idle, approximately 1500 revolutions per minute, until the engine temperature reaches 190^{o}, and then stop the engine. This will open the thermostat and circulate the coolant.

(5) Depressurize the system.

(6) Fill the cooling system with proper antifreeze solution until the surge tank is 3/4 full.

(7) Secure the filler cap to the surge tank.

(8) Run the engine at a fast idle, 1500 revolutions per minute, until the temperature reaches 190^{o}, and then stop the engine.

(9) Depressurize the system and make sure that the proper coolant protection is provided.

(10) Secure the filler cap to the surge tank.

(11) Start the engine and check the cooling system for leaks.

4. REPLACE FAN DRIVE AND FAN ASSEMBLY

a. Remove Radiator and Fan Shroud Assembly.

(1) Drain the radiator and close the drain cock.

(2) Loosen the radiator inlet, outlet, and surge tank hose clamps and remove the three hoses from the radiator.

(3) Remove the capscrews, washers and insulators from the front and rear supports.

(4) Disconnect and plug the oil cooler hoses and mark them for reinstallation.

(5) Uncouple and plug the fan drive quick-disconnect from the fan drive. With the radiator, oil cooler and fan drive hoses disconnected, the radiator, oil cooler and fan shroud are removed as a unit.

b. Remove Fan Drive and Fan

(1) Uncouple the fan drive hose quick-disconnect from the fan drive.

(2) Remove four socket-head screws securing the fan drive assembly to the water pump pulley, remove the fan drive assembly.

(3) Remove the four nuts and lockwashers securing the fan to the fan drive. Remove the fan. Discard the lockwashers.

c. Inspect Fan Drive and Fan Blade

(1) Inspect the clutch adapter for worn threads, cracks, or breaks. Replace it if it is defective.

(2) Inspect fan blades for cracks, chips, or other damage.

d. Install Fan Drive and Fan Blade

(1) Install the fan onto the fan drive and secure it with four lockwashers and nuts. Torque to 45 foot-pounds.

(2) Apply Loctite sealant to four socket-head screws and secure the fan drive assembly to the water pump pulley. Torque the socket head screws to 45 foot-pounds. couple the quick-disconnect on the fan drive. (OFF FRAME NO. 28)

e. Install Radiator and Fan Shroud Assembly.

(1) Install the capscrews, washers and insulators securing the radiator to the front and rear support brackets.

(2) Remove the plug and couple the quick-connect to the fan drive.

(3) Remove the plugs from the oil cooler hoses and connect them to the oil cooler.

(4) Connect the radiator inlet, outlet and surge tank hose to the radiator and tighten them with hose clamps.

(5) Connect the hydraulic control valve hose to the radiator and secure it with a hose clamp. The oil cooler, radiator and fan shroud are installed as a unit.

5. REPLACE HMMWVA2 ENGINE SERPENTINE DRIVE BELT

1. Serpentine Belt Removal.

a. Position 3/8 inch breaker bar on belt tensioner and move tensioner clockwise to loosen belt.

b. Remove belt from all component pulleys, idler pulley, and tensioner pulleys.

c. Release belt tensioner.

2. Serpentine Belt Installation

a. Have an assistant position a 3/8 inch breaker bar on belt tensioner and move tensioner clockwise.

b. Install the serpentine belt by feeding it into grooves on the following pulleys: Crankshaft, idler, alternator, power steering pump and the two upper idler pulleys. Continue feeding belt onto grooves on the water pump and tensioner pulleys.

c. Instruct assistant to release belt tensioner and remove breaker bar from tensioner.

REFERENCES:

TM 9-2320-280-20-1
TM 9-2320-280-20-2